Research Report 1439

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Simulation in Combined Arms Training: A Platoon-Level Battlefield Simulation

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ARI Field Unit at Fort Knox, Kentucky
Training Research Laboratory

U.S. Army

Research Institute for the Behavioral and Social Sciences

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This report describes the development and preliminary evaluation of a tank platoon-level battlefield simulation for training command and control skills in a classroom environment. Functional requirements for terrain, movement, detection/identification, engagement, indirect fire, communication, resource audits, postsimulation feedback, and the realization of these functional requirements are covered in detail. The system is described in terms of its hardware and operating characteristics. The results of pilot trials with lieutenants from the Armor Officer Basic Course and intact platoons (vehicle commanders only) from an operational tank battalion are described. The development of a Single Tank Tactical Exercise and the results of its use with students from the MOS 19K Basic Noncommissioned Officers Course (the M1 Abrams Tank Commander) are described.

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FOREWORD

The U.S. Army Research Institute has developed a research simulation designed to play the command and control (C^2) tasks attending such tank platoon exercises as Movement to Contact, Hasty Attack and Defend Battle Position. This simulation, called SIMCAT (Simulation in Combined Arms Training) is microcomputer-controlled, has a separate player position for the platoon leader, platoon sergeant, and two tank commanders, and has a free-play OPFOR station. Driving and gunnery are under the control of simulated crewmen who are activated by voice commands. A full 360° terrain base is accomplished using a map display without grid lines. Indirect fire and concealed minefields are available to both the friendly force and the OPFOR.

Trials with lieutenants from the Armor Officer Basic Course, intact platoon leadership from an operational tank battalion, and students from the MOS 19K (M1 Abrams) Basic Noncommissioned Officer Course (BNCOC) have shown that the SIMCAT reproduces many of the mission tasks and much of the confusion and stress of a typical field exercise. Trials have shown it to be a useful, low-level exerciser of C^2 skills.

This report summarizes the design and development of the SIMCAT, including the functional requirements, hardware, and operating characteristics, and summarizes the results of early trials. SIMCAT will be used to do research on the training of C^2 tasks in a laboratory environment.

This effort is part of the Fort Knox Field Unit's research program to apply new training technology to Armor skills training needs. The Field Unit's overall mission is to improve methodology basic to the derivation of Armor training and evaluation requirements and procedures, individual and collective training in Armor schools and operational units, and systems for integrating and managing Armor training. A Memorandum of Agreement covering the application of training technology to Armor skills training, "Establishment of Field Training Technology Activity, Fort Knox, Kentucky," was signed by HQ, TRADOC, USAARMC, and USARI on 4 Nov 83. The SIMCAT has been briefed and demonstrated for the CG, TRADOC (1985) and, the CG, USAARMC (1986), and continuous coordination/briefings have been held for the Technical Director, USAARMC throughout this developmental effort. Exercises are being developed for SIMCAT in cooperation with the Fort Knox Noncommissioned Officer's Academy for use in the MOS 19K Basic Noncommissioned Officer's Course. A similar effort is underway with the Armor School for the Armor Officer Basic and Advanced Courses. Plans have also been made to pilot SIMCAT technology with the South Carolina National Guard.

Edgar M. Johnson

EDGAR M. JOHNSON
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SIMULATION IN COMBINED ARMS TRAINING: A PLATOON-LEVEL BATTLEFIELD SIMULATION

EXECUTIVE SUMMARY

Requirement:

To develop a tank, platoon-level, battlefield configuration for conducting research on methods for training command and control (C^2) skills in a classroom environment.

Procedure:

Tank, platoon-level exercises that contained most of the C^2 tasks required of a platoon-sized unit were selected. The exercises selected were Movement to Contact, Hasty Attack, and Defend a Battle Position. Careful examination of these missions yielded the functional requirements for Simulation in Combined Arms Training (SIMCAT). Requirements were developed for the simulation of terrain, movement, detection/identification, engagement, indirect fire, communication, resource audits, and post-simulation feedback. Hardware that would permit the play of these functional requirements was identified and acquired. Software was written to realize these requirements on the acquired hardware.

The resulting hardware and software simulation was subjected to pilot runs with three different types of subjects: lieutenants in the Armor Officer Basic Course, intact platoons (vehicle commanders only) from an operational armor battalion, and students in the M1 Abrams (MOS 19K) Basic Noncommissioned Officer Course (BNCOC) (running a Single Tank Tactical Exercise).

Findings:

SIMCAT permits the play of the three tank platoon missions and presents the stimulus conditions for most of the C^2 tasks required. Soldiers can perform as the SIMCAT Controller with less than 1 day's training and can perform as subjects with as little as 15 minutes' training.

SIMCAT plays in real time and reproduces much of the confusion and stress found in a typical field exercise. Soldiers who have been subjects provide favorable reports regarding the realism of play. Commanders and instructors who have been exercise Controllers provide similar favorable reports.

Utilization of Findings:

SIMCAT is a one-of-a-kind prototype. Lessons learned with SIMCAT will be used to design a second-generation system that will be used to conduct research on training C^2 skills. SIMCAT, as it currently stands, has been found to be a useful low-level simulation and, as such, will continue to be used for research where it provides the necessary characteristics.

SIMULATION IN COMBINED ARMS TRAINING: A PLATOON-LEVEL BATTLEFIELD SIMULATION

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THE NEED FOR A PLATOON-LEVEL C^2 TACTICAL RESEARCH SIMULATION

> "Battles can be lost at any level in the chain of command, but are only won by companies, platoons, squads, and crews. . . . skillful execution of fundamental individual and small unit tasks is a prerequisite for mission accomplishment."
>
> "Small unit actions are not only the most important but also the most difficult . . . A great deal of practice is required."
>
> "There is nothing more important to success on the battlefield than effective command and control."

The above quotations from BG E. S. Leland's "NTC Observations" (Leland, 1985) highlight command and control (C^2) as a critical ingredient in battlefield success. General Leland's remarks are all the more important because they are based on his observations as Commander of the National Training Center.

Training in these "fundamental and small unit tasks" starts in the Army school setting. For Tank Platoon Leaders and Platoon Sergeants, this training is carried out at the US Army Armor School at Fort Knox, Kentucky. For Tank Commanders, this training is given in the Basic Noncommissioned Officer's Course (BNCOC). Training starts in the classroom where the basic knowledge requirements are taught. These knowledge requirements are integrated and skill components introduced during training designed to transition the student from the classroom to the field, usually on a sand table or a board game. Field integration and skill development take place during field exercises. Observations of these field exercises shows a need for more effective training before the field exercise. Students are going to the field unprepared to perform C^2 tasks in a combat environment. Observations at the NTC show a similar lack of readiness.

Interviews with officers who had been to NTC showed agreement with the notion that participating units perform poorly at platoon level. Among the comments during the interviews were: troops are unable to transition from moving to fighting, leaders do not control and coordinate fires, planning for indirect fires does not occur, effects of indirect fires are ignored, poor communications are prevalent, and C^2 is a major problem. (Henriksen et al, 1984)

Training basic C^2 skills in a field environment is too expensive. The cost of operating and maintaining a tank is approaching $280.00 per hour. In an era of diminishing resources for training, the mastery of fundamental

tactical skills should take place before exposure to the complex performance requirements of a field exercise. Fundamental skills can be learned less expensively on a sand table or board game.

The problem with using existing simulations to train tactical skills at the platoon level is that they do not do this effectively. Although computer supported battle simulations have existed for some time, these simulations (i.e., CATTS, CAMMS, BATTLE) are geared to the battalion and brigade echelons and do not require players to be fully interactive with the simulation. Board games are not much better. Awkward game mechanics and length of time to play the game present serious problems. For example, up to eight hours of Dunn-Kempf game play may be required for as little as 30 minutes of combat. Dunn-Kempf does not require physical separation of players on the same team even though separation is common in combat, thus requiring the use of radio communication. As a consequence, communication among players is informal and conversational rather than resembling the radio communication required between vehicle commanders in a combat or engagement simulation environment (Jones et al, 1980). TRAX, a tank platoon exercise that uses the Dunn-Kempf board and miniature vehicles to run platoon missions generated from the Tank Platoon ARTEP Mission Training Plan requires more realistic communication between players but still doesn't get around the ability of each player to see the entire battlefield (Lampton, 1985; Bessemer & Lampton, 1985).

Since existing tactical simulations are at the wrong unit level and board games do not faithfully reproduce the C^2 problems inherent in combat, ARI embarked on a program of research to find ways of conducting this training in a more effective and efficient manner. A necessary prerequisite to this research was a system that would allow the play of C^2 skills in the laboratory environment. SIMCAT was developed to satisfy this requirement.

A FUNCTIONAL DESCRIPTION OF SIMCAT

Overview

SIMCAT contains six stations -- four vehicle commander stations, an OPFOR station, and a Controller station. Each station has a visual display showing an overhead view of a map. Instead of the standard military map, a nonmilitary map containing fewer navigational cues is displayed.

Superimposed on each display are graphic representations of friendly tanks controlled by the vehicle commanders and of enemy tanks and BMPs controlled by an OPFOR player. Each vehicle commander can see his tank and other weapon systems that are in his line of sight. Each vehicle commander can select from among three visual displays--a close-up view which maximizes terrain detail, a far view which maximizes the area of the display, and an intermediate view. The OPFOR display shows graphic representations from the viewpoint of an OPFOR vehicle selected by the OPFOR player. Line of sight rules for the OPFOR are the same as for the friendly force. The display available to the controller shows all weapon systems regardless of line of sight.

Each vehicle commander can move his own tank, rotate its turret, communicate, and fire the main gun and the coaxial machinegun. The vehicle commander can move his tank and fire its weapons by using voice commands as if an actual crew were present or by means of a touchpad. When a vehicle commander issues a fire command, the system executes the command and automatically resolves the engagement. When a target is destroyed, a "destroyed vehicle" icon is displayed in place of the regular vehicle icon. The OPFOR controls the movement and firing of each of his vehicles/weapon systems and can implement an automatic vehicle movement routine. For automatic movement, the OPFOR marks the route with a cross-hair from the touchpad. The selected vehicle will follow the route when actuated.

Communication on both company and platoon radio nets is available, by wire, through the standard CVC helmet. Voice actuated functions are effected through the CVC helmet when the selector switch is on the intercom and the player has trained the computer to recognize his voice. Communication is also possible with hand and arm signals from the touchpad. A selected hand and arm signal replaces the vehicle icon for three seconds when selected. The system provides indirect fire to the friendly force from the Controller station. The OPFOR controls his own indirect fire from his touchpad.

Terrain. SIMCAT terrain, a 1:24,000 geodetic map without grid lines, has been digitized and stored on a videodisc. The map is displayed on a color monitor and may be shown right side up and upside down and is tilted from a true north justification. The map has been digitized into 30 x 30 meter grids and each grid coded for vegetation, water, and relief. Each vehicle commander has available a corresponding 1:50,000 standard military map. Three magnifications of the terrain are available from the function pad (450 x 600, 2250 x 3000, or 4950 x 6000 meters). Trafficability is determined by 30 x 30 meter grid coding. The OPFOR visual display is identical to that presented to vehicle commanders and is presented from the vantage point of the OPFOR vehicle selected for viewing. Both vehicle commanders and the OPFOR see their vehicle centered on the color monitor. As the vehicle nears the edge of the visual display, the map shifts to re-center the vehicle. The Controller can view the entire terrain data base with all vehicles displayed or can select and view any vehicle commander's screen or the OPFOR screen. All stations provide a 360° perspective.

Movement. Prior to system operation, vehicle commanders complete a voice enrollment process during which they speak the words and phrases necessary to operate the vehicle commander's station. The speech is digitized, compressed, and stored as a template by VOTAN[1] software. Vehicle commanders and the OPFOR can control the direction and speed of their vehicles. Vehicle commanders issue voice commands to a simulated driver via the intercom switch on the CVC (e.g., "driver, moveout ... turn right ... guide right ... steady on") that are converted to keystroke input by the VOTAN software. The OPFOR controls vehicle movement by pressing function keys on a keyport using either direct movement commands or a forecast route method in which a path can be

[1]The VOTAN VPC 2000 Voice Terminal is a hardware and software system that recognizes and processes, but does not synthesize, speech.

selected for the unit to follow. Maximum speed varies with terrain characteristics. Actual speed for friendly tanks is displayed on the vehicle commander's color monitor. Vehicle commanders have engine on/off control. Both vehicle commanders and the OPFOR have a function key which displays current vehicle status (engine on/off, type of terrain occupied, and vehicle status such as "fully functional" or "firepower casualty"). Vehicle commanders use touch sensitive keys on the keyport to control turret/main gun orientation.

Detection/Identification. Friendly and OPFOR units are represented by graphic icons. Each vehicle commander display shows his tank highlighted with a green turret. Other friendly units (blue) and OPFOR units (red) are shown with black turrets. Vehicle commanders and the OPFOR are able to view, in 360°, all the terrain displayed on their monitor but only those icons with which they have line of sight. The OPFOR views the terrain from the vantage point of one of his vehicles. The Controller can monitor the view of any of the friendly or OPFOR displays or can get a "God's Eye" view of the entire area without regard to line of sight.

Engagement. Vehicle commanders control main gun orientation from the function pad. To check main gun orientation, the vehicle commander can press a key that causes a line to be extended from the main gun to the edge of the visual display. The turret/main gun control key provides similar feedback. If the turret is properly oriented (for target handoff), gunnery engagements may be initiated. The vehicle commander issues a fire command to his simulated loader and gunner over the intercom ("Gunner, SABOT, Tank" or "Gunner, HEAT, PC"). If the fire command is appropriate for the vehicle being engaged, the vehicle commander will get auditory feedback from the simulated crew via stored, digitized speech ("Ammo up... Identified"). An inappropriate fire command triggers a "Cannot Identify" from the simulated gunner. On hearing an "Identified" from the gunner, the vehicle commander issues a "Fire" command and SIMCAT resolves the engagement. OPFOR engagement is from the keypad. The weapon systems available are the tank main gun and the Sagger missile. Keypresses allow the OPFOR to select a target by moving a crosshair from one target to the next. Turret orientation is adjusted automatically once a target is selected. Several engagements can be set up, one for each OPFOR unit. No engagement will be executed, however, until the "fire one" or "fire all" key is pressed. Target engagement is resolved automatically by SIMCAT. Outcomes are based on probability tables that are adjustable. Engagements are displayed graphically by firing and explosion icons. If a total kill, the unit icon is replaced with a "junkpile" icon and an appropriate message is displayed on the "killed" station monitor.

Indirect Fire. Vehicle commanders can call for indirect fire by requesting a fire mission (grid, shift, or polar) from the Controller acting as the Company/Team FIST. The Controller enters the UTM (Universal Transverse Mercatur) coordinates into the system directly from his console. Missions are automatically fired after an appropriate delay. The OPFOR allocates indirect fire directly from his keypad. All missions are displayed as a standard sheath.

Communications. The communication network is an independent system of four CVC helmets, an OPFOR headset, and a Controller's headset and communications control box. Vehicle commanders issue voice commands via an intercom

to a simulated crew. Vehicle commanders can communicate with each other and with the Controller over a platoon and a company net. The OPFOR communicates with the Controller over a Controller net. The Controller can monitor or talk over any of the three networks (but not the intercoms) and can introduce white noise to jam the platoon or company nets. In case of jamming, or when there is a need for more secure communication, vehicle commanders can communicate using hand and arm signals. Fourteen such signals are represented in SIMCAT. The vehicle commander presses the appropriate symbol on the function pad to temporarily replace his tank icon with a graphic representation of the chosen signal.

Time. The controller can stop and restart a simulation at any point for training or administrative purposes. He can also specify a specific simulation time he wishes to recall (in 15 second intervals). When this time has been selected, a single screen is displayed (forward or backward panning is not possible).

Post-Simulation. Audio playback requirements have been partially met by providing a jack into which a tape recorder may be plugged. The Controller must select the net to monitor and turn the tape recorder on/off manually to capture net traffic for re-play. The Controller can specify a simulation time in hours and minutes and SIMCAT will recall a single, designated screen.

SIMCAT vs. SIMNET. This report describes SIMCAT, a platoon-level battlefield simulation for conducting research on C^2 training issues. The Army is developing and fielding a simulator called SIMNET (Simulation Networking). The similarity in these two acronyms may cause confusion. The following description of SIMNET is provided to help the reader keep these systems clearly separated. SIMNET is a project of the Defense Advanced Research Project Agency (DARPA). DARPAs goal is to network low-cost simulators over long distances to permit exercises to be conducted simultaneously by battalions or larger units. SIMNET will provide full-crew modules that can operate independently or can be netted locally to form platoons, companies, or battalions. These are fully interactive and will permit tactical training in a simulated combat environment in real time with live forces opposing one another in free play.

SIMCAT SHORTFALLS

Terrain. The original requirement was for each player to be able to view only that terrain with which he had line of sight. In SIMCAT, line of sight has been programmed only for icons, not for terrain. The OPFOR player was supposed to be able to view a larger area of terrain than the vehicle commanders (in recognition of the fact that he may be called upon to control up to ten, rather just one, vehicle). In fact, the OPFOR viewing area is the same as the vehicle commander's. An early thought to provide the Controller with the option to view offensive, defensive, and contact zone representations has not been programmed.

Movement. An original requirement was to restrict movement to the platoon zone of operations by either having the icon stop automatically when it reached the boundary of the platoon zone or having an audible tone sound

at that point. In fact, movement is possible throughout the data base. An OPFOR requirement to reduce OPFOR workload by allowing the movement of vehicles as a group was not programmed.

What was felt to be a critical functional requirement to limit icon movement to realistically traversable terrain, i.e., movement up cliffs and through lakes would be impossible, was not realized. All terrain is traversable.

Detection/Identification. SIMCAT represents all tanks, BMPs, and some events (i.e., weapons signatures, indirect fire) but does not represent transient conditions (i.e., smoke, dust). Visual detection depends only on line of sight, range, obscuration, and the use of thermal imaging are not considered. Auditory cues, i.e., guns firing, indirect fire, etc., are not provided.

Engagement and Indirect Fire. The only serious shortfall here is that the SIMCAT does not maintain a munitions or an indirect fire audit. This has little effect on scenario play since resource allocations generally exceed resource expenditures. Its real effect is on post-simulation feedback where these engagements cannot be detailed.

Communications. There are two problems with the communications system. One has to do with its capability to create ECM (electronic countermeasures) and the players ability to communicate during ECM. Only white noise is available for jamming which limits the kind of ECM that can be played. When ECM is present, players have hand and arm signals available on the touchpad. The icon that comes up on the monitor when a hand and arm signal is selected is too small to be quickly and easily distinguishable. The second problem concerns the communications capability at the platoon leader and platoon sergeant stations. These players should be able to simultaneously receive on both the company and platoon nets while being able to transmit on one of these. Actually, they can only receive and transmit on one of these nets, depending on which net is selected on the communication control box.

Time. SIMCAT does not have a replay capability. When the controller selects a time or an event (based on time) for replay, all SIMCAT will allow is the display of a single screen (i.e., controller, OPFOR, or player) at the simulation time selected. SIMCAT will not then replay the scenario, i.e., reproduce the actions of the players, either backwards or forwards. This means that actions taken by the players cannot be shown during post-simulation after action reviews. The simulation time selected by the controller must be based on an estimate made by him since SIMCAT does not provide a convenient clock for this. Once a simulation time has been selected and a screen displayed, SIMCAT will not allow the selection of a second event or time earlier in the scenario. Only times later in the play are available. Finally, participants are not cued when the simulation is stopped or restarted. They must be told this by the controller.

Post-Simulation. No forward or reverse visual playback is possible. Auditory playback is limited to what has been captured on the tape recorder. No synchronization of auditory and visual feedback is possible. No hard copy output is available.

SIMCAT HARDWARE AND SOFTWARE [1]

SIMCAT Hardware. Four vehicle commander stations are each equipped with an IBM PC with 640 Kbytes of random access memory (RAM), a color monitor, a local disc drive (360K), a device controlled disc drive (1.2 MB), an 8087 math coprocessor, a Tecmar Graphics Master Board, a VOTAN VPC 2000 voice board, a Polytel Keyport, and a videodisc player. The OPFOR and Controller stations are equipped with an IBM PC with 640 Kbytes of RAM, a color monitor, a monochrome monitor (with display and adapter cards), a local disc drive (360K), a device controlled disc drive (1.2 MB), an 8087 math coprocessor, a Techmar Graphics Master Board, and a videodisc player. The OPFOR station also has a Polytel Keyport. The system file server consists of an IBM PC with 256 Kbytes of RAM, a single disc drive (360K), and an 8087 math coprocessor. The file server is connected to an XCOMP 31.5 MB hard disc drive running the X-NET local area network.

SIMCAT Software. SIMCAT software is written in MODULA-2. Approximately 63 modules control the various operations needed to run the simulation and to access the necessary data bases. The Fort Knox database (on videodisc) covers an area of some 8 x 20 kilometers northwest of the Fort Knox garrison and contains elevation and vegetation information, line of sight, grid coordinates, and information needed to access the appropriate frame from the videodisc. The conflict resolution database contains the hit/kill probabilities used to determine engagement outcome (miss, movement kill, firepower kill, or total kill). The initial conditions database contains scenario specific unit information that is generated by the Controller: number of OPFOR units (zero to ten), types of OPFOR units (T-72s, BMPs, or any combination of the two), starting location of friendly and OPFOR units, map orientation on the player monitors, number of starting rounds of ammunition, and minefield locations.

PILOT EVALUATIONS

Early in the development cycle of SIMCAT (February 1985), system capability to play the conditions necessary for conducting platoon-level battlefield simulations was checked by running a series of exercises using four lieutenants who were waiting to start the Armor Officer Basic Course (AOB) at Fort Knox. System development was not complete but was far enough along to get an early reading on the system's utilities.

The lieutenants were not selected in any way; they were waiting for their Armor Officer Basic (AOB) class to start. All were college graduates and had received their commissions through ROTC or the U.S. Military Academy. As such, they had all completed some form of basic military education (ROTC classroom instruction and summer camp or four years at West Point). Three of the lieutenants had just entered active duty. The fourth had four years prior enlisted service in the Marine Corps and five years prior enlisted

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[1] This summary is taken from Campbell (1985).

service in the Army in MOS 96B (Intelligence Analyst). None had previous experience with the M1 tank. Only one had previous experience with microcomputers. None had received any of the tactical or gunnery instruction in AOB.

The exercises were conducted at the hardware/software contractor's facility by a Lieutenant Colonel (the ARI Fort Knox Field Unit Research and Development Coordinator) and an enlisted instructor from the Armor School Weapons Department (a Sergeant First Class with over 12 years experience in armor). The actual exercises conducted were tactical tank tables C3, C4, D1, D2, E1, E2, F4, G1-G6, H1, H2, I2, I5, and I7 from FM 17-12-1, Tank Combat Tables (M1), 1 December 1984.

The exercises were run for three days with the lieutenants switching roles as platoon leader, platoon sergeant, and tank commander. Their comments on the system, as it was configured at that time, are summarized below.

<u>Computer Controls</u>. The hand and arm signals were identifiable on the touch panel but less so on the visual display. They were satisfied with the method of selecting visual display magnifications. Engine control worked well. They felt that the "tank status" display gave them all the information they needed. They did not like the turret traverse controls on the touch pad, preferring a joystick. Voice control over the driver and gunner/loader got a mixed response depending on how reliably SIMCAT heard and carried out their verbal commands (which is dependent on the stability of their utterances). When the voice system worked well, they preferred it to the touch panel.

<u>Video Display</u>. They felt that the icons were easily identified but that it was hard to distinguish between friendly tanks.

<u>Tank Tables</u>. All four lieutenants felt that they learned a great deal from running the exercises. They felt the exercises were realistic in that they generated confusion and stress on contact with the OPFOR, played the various difficulties and situations that can arise during a mission, and showed them how easily things can go wrong.

<u>Communication System</u>. They all had trouble using the communication system but were able to communicate effectively when the system was working. They were all able to recognize when jamming occurred.

<u>General Learning</u>. Each lieutenant was asked to evaluate his specific knowledge/understanding of ten topics, on a scale of 1-5 (1 low; 5 high), for both "before" and "after" these exercises. Means and gain scores are shown in Table 1.

Table 1

"Before" and "After" Means, and Mean Gain Scores for Ten Topics (1 = low; 5 = high)

Topic	Before	After	Mean Gain
Land Navigation	3.75	4.25	.50
Tank Gunnery	1.50	2.50	1.00
Radio Procedures	2.00	3.00	1.00
Tank Tactics	1.50	3.25	1.75
Enemy Tactics	2.50	3.50	1.00
Hand and Arm Signals	1.25	3.00	1.75
Movement Techniques	2.75	4.00	1.25
Enemy Organization	2.50	3.25	.75
Tank Company Organization	3.00	3.75	.75
Tactical Use of Terrain	2.25	3.50	1.25

General Comments. The lieutenants felt that the SIMCAT would be easy to operate when the "bugs" were worked out, that it gave then "real" experience in C^2, that it gave them a "leg up" on other AOB students, and singled out command and control, formations, movement techniques, hand and arm signals, and use of terrain as topics on which they had learned a great deal.

The ARI Research and Development Coordinator and the Weapons Department Instructor agreed with this assessment. They felt that these lieutenants were showing tactical behaviors usually evident only after several days exposure to the AOB "Ten Day War" (a large tactical exercise). They were particularly impressed with gains in planning behavior, map reconnaissance, route selection, control during movement to contact and during contact, fire commands, reporting procedures, and in the ability to change operations when original plans had been frustrated.

A second series of trials was held at Fort Knox after the SIMCAT had been delivered and site-tested by the hardware/software contractor and ARI. In this series, intact platoon leader (platoon leader, platoon sergeant, and two tank commanders) were used as subjects. Platoon personnel came from an operational tank battalion at Fort Knox. For these runs, the Company Commander acted as Controller while ARI personnel, under his direction, operated the OPFOR station. Two different platoons were used.

The Company Commander chose Movement to Contact and Hasty Attack as the two scenarios to play. He selected the grid coordinates for the Assembly Area, designated the platoon area of operations, and positioned the OPFOR vehicles during scenario development with the ARI operator. He developed and issued an operations order to his platoon leader to start the exercise. Players were encouraged to use the voice actuated driver and gunner/loader as much as possible and only have recourse to the touch pad when the SIMCAT refused to recognize their voice. Multiple runs were made through this single scenario by the platoons.

The exercise for each platoon started with each player creating a voice print on the VOTAN. This was followed by an orientation to the SIMCAT and a 10-15 minute "free-play" period where the vehicle commanders became familiar with SIMCAT operation and manipulation of the controls.

Both platoons showed almost identical performance on the exercise. For both platoons, the first run was aborted after approximately 10 minutes by the Company Commander because platoon members had become widely separated and the platoon leader had not designated rally points for regrouping. Platoon members were also unable to get into, and stay in, the platoon formations directed by the platoon leader.

Second runs were better than first runs. The first run had taught the platoon leader to designate rally points, and had pointed out the necessity to maintain visual contact between vehicles during formations. Second runs were stopped when the OPFOR brought artillery fire on the platoon and the platoon took no action in response. The Company Commander held a short debriefing session and explained the necessity to go to an appropriate MOPP (Mission Oriented Protective Posture) level, accelerate through the barrage, and submit a spot report (SPOTREP). Second runs were then restarted at the point where they were stopped and were aborted when contact was made with the OPFOR because the platoon leader made no attempt to direct the activities of the platoon. Each tank fought individually. No SPOTREPs were made on contact nor was a casualty report made.

Third runs continued to show the learning that was taking place. Movement to Contact was more carefully thought out, map reconnaissance led to a more careful route selection, movement to contact was a more cautious exercise, formations were better, reports were more frequent and concise, correct actions were taken when under artillery fire, and an attempt was made by the platoon leader to control actions on contact.

The Company Commander was pleased with what had transpired. He felt he had learned a great deal about the two platoons and knew what training priorities he needed to initiate for them. The platoons were less pleased since they had been found wanting by their commander. They agreed, however, that they had learned some things as well.

The only SIMCAT utility that proved to be a problem during these exercises was the VOTAN. Subjects were not used to carefully disciplining their voice during periods of activity or stress. Voice prints were made in very carefully modulated tones; voice commands were "yelled" during operational problems or on contact. Some of the platoon players were getting better at controlling their voices after the third run.

DEVELOPMENT OF A SIMCAT SINGLE TANK TACTICAL EXERCISE

Recognition of a need for collaboration between technology developers and trainers has led the Training and Doctrine Command (TRADOC), the Armor Center (USAARMC), and ARI to develop a joint activity for the application of training technology to an operational military training course. The activity, the Fort Knox Training Technology Field Activity (TTFA) has a mission to systematically identify, evaluate, and introduce new training methods, techniques, technologies, and models to Army training. The initial effort of the TTFA is focused on the MOS 19K Basic Noncommissioned Officer Course (BNCOC) for training M1 Abrams Tank Commanders.

In March 1986 the BNCOC senior instructor came to the TTFA to see if any of the training technology already being evaluated would be available during the class schedule. The Noncommissioned Officer's Academy (NCOA) had been told to prepare for the elimination of STX (Situational Training Exercise) time from the class schedule and he wanted to see if they could use SIMCAT to run some exercises during the time originally planned for the STX. This request fit into TTFA plans for evaluating the SIMCAT as a tool for exploring single tank tactical exercises. Since the SIMCAT had been designed to examine platoon-level C^2 issues, there was some doubt about its efficiency as a single tank simulation.

A draft field STX was modified for SIMCAT by pulling out those situations that required the use of a tank, pyrotechnics, operational equipment, or actual terrain. The exercises remaining tended to be C^2 exercises. This grouping of exercises was called the Single Tank Tactical Exercise (STTE) and was prepared for play on the SIMCAT.

The objective of the SIMCAT runs with this BNCOC class was to pilot the STTE. Three different SIMCAT STTE were developed for 19K BNCOC. Each exercise had four different "lanes" in the scenarios programmed into SIMCAT. Each "lane" could be run forward and backward. This provided 24 different STTE scenarios. The STTE all contained the same stimulus conditions but on different pieces of terrain and in a different order. Draft score sheets were developed for capturing performance information from each STTE run and procedures for managing the runs were developed.

Eight 19K BNCOC students (all the MOS 19K input to the BNCOC class) were available for the runs. Initial plans called for the NCOA to provide three instructors. ARI was to provide the SIMCAT operator and an OPFOR player.

As originally conceived, each STTE would contain the following opportunities for independent action by a TC/Driver pair.

<u>Actions in the Assembly Area</u>. The Tank Commander (TC) was given his mission and route and was given any other information or orders dictated by the scenario.

Actions at the Start Point. To start the exercise, each TC was required to enter the radio net, respond to a challenge with an authentication, and decode a message using the numerical cipher/authentication system.

Evade a Minefield. The TC was given the map coordinates of a minefield, in code, during the Actions at the Start Point. He had to decode these coordinates and plot the minefield on his map. During the exercise, when his tank got near the minefield, he had to locate the minefield area on the visual display (the minefield did not show up in any way on the SIMCAT display), select a route around the minefield, and direct the driver through his selected route.

Evade OPFOR Indirect Fire. At one or more points during the SIMCAT run, the OPFOR player brought indirect fire on the tank. The TC had to direct that hatches be closed, tell the driver to accelerate through the barrage, direct the crew into MOPP-4, use the M256 Chemical Kit to identify the agents mixed with the High Explosive, prepare and submit an NBC-1 report, encode/decode messages related to the action, and direct MOPP-2 when appropriate.

Engage a T-72. Each lane contained a T-72 placed in such a position that it became observable from the route designated for friendly movement. When it appeared within line of sight on the visual display, the TC had to acquire and identify it as a T-72, issue the appropriate fire command to the crew (played by the second BNCOC player at the station), engage (and destroy) the target if possible, and report the contact (and destruction) to the Platoon Leader by six-digit grid coordinate, in code.

Electronic Countermeasures. At some point during the exercise, the Controller would introduce white noise into the platoon and company radio nets as a simulated "jamming" of the friendly communications system. The TC had to identify the jamming technique being used, try to transmit through the jam, simulate a change to an alternate frequency, and send an interference report to the Platoon Leader.

Call For/Adjust Indirect Fire. The TC was given a target by the Platoon Leader on which he was to call friendly indirect fire. This was usually a reconnaissance by indirect fire of a wood line of other terrain feature. The TC had to identify the terrain feature on his map using the six-digit coordinates provided, identify it on the visual display when it became visible, make a correct call for fire, and then adjust fire as required.

Engage a BMP. Each lane contained one BMP placed in such a position that it became visible from the route designated for friendly movement. When it appeared within line of sight on the visual display, the TC had to acquire and identify it as a BMP, issue the appropriate fire command to the crew, engage (and destroy) the target if possible, and report the contact (and destruction) to the Platoon Leader by six-digit grid coordinate, in code.

Actions at the Release Point. On reaching the release point, the TC had to submit a situation report, encode and decode messages as required by the Controller/Platoon Leader, and leave the radio net.

The following procedures were planned for the three day exercise.

Instructor Orientation. Since all evaluation/critiques of student performance would be done by NCOA instructors, they would be oriented to their roles before the trials began. They would be familiarized with the SIMCAT, the scenarios, performance checklists, and the operation of the Controller's station. One instructor would operate from the Controller's station as the Platoon Leader. Two instructors would be evaluators, being positioned so that each could observe two player stations.

Student Orientation. Students would be shown how to operate the controls at the player's station. Two students would be placed at each station, one to play TC and the other to play the crew. Voice enrollment would not be used.

Practice Runs. Each TC/Driver pair would be given two practice runs. On the second run they would change positions.

Evaluated Runs. Four "record" runs would follow the practice runs. On Run 3, each TC/Driver pair would run a given lane. On Run 4, they would switch roles and run the lane again. On Run 5, they would switch roles and run a second lane. On Run 6, they would switch roles and run the second lane again. Runs 3 and 6 would be evaluated by the Controller/Instructor and the station evaluators. TTFA personnel would tend to the SIMCAT hardware, evaluate the process, collect data on the process to use in finalizing the procedures, and provide an OPFOR player.

STTE RUNS IN BNCOC

The procedures outlined above were generally followed. Two NCOA instructors were used at the Controller's station, one to run the exercise, the other to grade the accuracy of the reports being sent in by the TC players. Runs 3 and 4 were used by the instructors to get oriented to the evaluation requirements and to debug the performance checklist. Runs 5 and 6 were evaluated. During the evasion of OPFOR indirect fire, no Chemical Kit was available so use of the Kit could not be simulated. Also, crewmen were directed into a modified MOPP-3 (mask with hood only) because the students did not have all the MOPP equipment to go to a full level 3 or 4. Finally, students were required to provide the Controller with a six-digit fix on their position at several points during the exercise. This required encoding the coordinates (and decoding at the Controller's station).

Data on student performance showed as much variability by evaluator as by TC/Driver pair (see Table 2). Instructor 1 evaluated 65% of the measurable events; Instructor 2 evaluated 87%. TTFA observers and the NCOA cadre at the Controller's station agreed that the two evaluators also appeared to have different standards for acceptable performance. They differed considerably in their attentiveness to the evaluation task. Everyone agreed that a high degree of vigilence is required to collect data during a SIMCAT STTE. One evaluator can collect data on two player stations simultaneously if well trained, vigilent, and if scoring is for a school GO/NO GO decision. Scoring

for research quality data would require one evaluator for each station. TTFA personnel and NCOA cadre identified some evaluator assistance items that needed to be fabricated, i.e., each evaluator needs a map with all the action points pre-plotted. A second evaluator at the Controller's station is necessary to grade radio traffic and keep track of each tanks location on a standard 1:50,000 map.

Table 2

Percent of Requirements Scored "GO" and Percent of Requirements Scored by the Evaluators

	TC/Driver Pair							
	1		2		3		4	
	Run1	Run2	Run1	Run2	Run1	Run2	Run1	Run2
Instructor 1								
"GO" rate	62	45	74	78				
% Req Scored	81	62	59	56				
Instructor 2								
"GO" rate					65	81	59	93
% Req Scored					97	84	84	84

Empirical data in Table 2 show modest gains in student performance. TTFA observers and the NCOA cadre, however, felt that gains in student performance from Run 3 through Run 6 were quite obvious. Four task areas showed considerable gain; map reading, using the CEOI (Communications-Electronics Operating Instructions), encoding and decoding messages, and frequency and accuracy of reporting. On Runs 3 and 4, many reportable incidents were not reported, reports were not properly formatted, reports were too rambling and disjointed, reports were not timely, work in the CEOI was very slow, CEOI accuracy was poor, and map reading skills were not much in evidence. By runs 5 and 6, many of these performance deficits were showing marked improvement. The students were getting much faster and more accurate in the CEOI, they were making fast and more accurate reports, and they were beginning to show behaviors that they had not shown during the earlier runs, notably, more efficient control of the Driver by the TC and more careful use of terrain during movement to contact.

It was much more difficult to manage four two-student teams each running a separate exercise on an independent piece of terrain than it was running a platoon exercise. Running a SIMCAT STTE parallels what would be required in the field to conduct such an exercise, however. Running four separate STTE simultaneously requires two individuals at the Controller station to manage the exercise and encode/decode radio traffic and an evaluator per station for data collection. In addition, a SIMCAT operator is required to bring the system up, re-initialize when necessary, correct system "crashes," and act as the OPFOR player.

TTFA observed the BNCOC students throughout the trials. A problem was discovered in SIMCAT operations as conceived for these exercises. Both students had physical access to the touch pad, map, and other materials at the student station. Strong students pre-empted weak students unless warned by the evaluators. That is, the "Driver" would plot on the map or encode/decode, or the "TC" would drive/fire the tank. For optimal simulation, some sort of barrier is needed that will allow both players access to the visual display but will prevent the TC from driving/firing and will prevent the driver from taking actions that could only be taken from the TC's station.

Students learned to operate SIMCAT controls in about a half hour (with no voice enrollment). Practice runs took about 30-45 minutes. Runs for record took longer, as they should have, because students were making more reports and generally being more tactically careful and proficient. Record runs took about an hour to complete. For research purposes, a whole day on SIMCAT for a BNCOC type group is probably too much at one time. Two half days appear to be better. In two half days, four two-student teams can complete the orientation to SIMCAT, learn to operate the student station, complete two practice runs, and run six STTE.

These runs in BNCOC have proven that the SIMCAT is a viable system for conducting single tank tactical simulations where such simulations are needed to examine training issues in such courses as Basic Armor Training and BNCOC and for Reserve Component training problems involving the lack of field training time and resources.

UTILIZATION OF FINDINGS/FUTURE PLANS

SIMCAT, as it currently stands, has been found to be a useful, low-level, simulation. As such, it will continue to be used for research where it provides the necessary characteristics. Research will continue on the capabilities of low-fidelity, microcomputer-driven, videodisc based battlefield simulation for generating the battlefield cues and player response mechanisms necessary for meaningful C3 training exercises in the classroom. Work will continue to develop and field validate STTE suitable for implementation in CMF 19 BNCOC. Such exercises will be designed to supplement current training in the classroom and the field and to replace the STX where and when necessary.

Exercises like the STTE would also be useful in more advanced courses where platoon sergeants and platoon leaders are taught platoon-level C3 skills. It may even be possible to expand the meaning attached to the SIMCAT icons for exercises at the company-team level. The suitability of SIMCAT-like, hardware and software architectures for generating good C3 training scenarios at these higher skill levels has yet to be shown.

An additional area for exploration is the joint STX concept. An often heard complaint is that it is almost impossible to provide NCOs and Officers in training with meaningful C3 exercises where the other players are actual lower level leaders. For example, when new tank platoon leaders are being trained, they learn their C3 skills with other lieutenants or instructor

personnel as crewmen. They then go to their first assignment having never operated in a tactical environment with real platoon sergeants and tank commanders. With SIMCAT-like technology, it should be possible to generate exercises where platoon leaders in training can run C3 problems while interacting with platoon sergeants from an advanced NCO course and tank commanders from a BNCOC. This would also provide similar experiences for the NCOs.

SIMCAT is a one of a kind prototype. Lessons learned with SIMCAT are being used to design and develop a second generation system. This system, called Platoon Leader Battlefield Simulation (PLBS) will correct most of the shortfalls in SIMCAT. The PLBS, even more than the SIMCAT, should prove useful in evaluating the role of such technology in C3 training for platoon-level leaders.

REFERENCES

Bessemer, D. W. (1985). A combat gaming method for tank platoon leader training: TRAX I (Research Product 85-36). Alexandria, VA: U.S. Army Research Institute. (AD A170 950)

Campbell, J. (1985). SIMCAT. Bulletin of the Command and Control Microcomputer User's Group, 4(7). Fort Leavenworth, KS: U.S. Army Communications-Electronics Command.

Drucker, E. H. (1986). Guide to the operation of SIMCAT (Research Product 86-29). Alexandria, VA: U.S. Army Research Institute. (AD A175 701)

Hannaman, D. L., Drucker, E. H., & Childs, E. L. (1985). Development of the functional requirements for SIMCAT (Research Report 1394). Alexandria, VA: U.S. Army Research Institute. (AD A169 897)

Henriksen, K. F., Jones, D. R., Sergent, D. L., & Rutherford, B. E. (1984). Assessment of tactical training methodologies (Research Report 1385). Alexandria, VA: U.S. Army Research Institute. (AD A168 938)

Jones, D. R., Wylie, P. B., Henriksen, K. F., Shriver, E. L., & Hannaman, D. L. (1980). Battle simulation board games: An analysis in terms of design characteristics and leader skills (Research Note 80-2). Alexandria, VA: U.S. Army Research Institute. (AD A082 930)

Lampton, D. R. (1985). TRAX II: Computer-assisted platoon tactical training (Research Product 85-17). Alexandria, VA: U.S. Army Research Institute. (AD A163 176)

Leland, E. S., Jr., BG. (1985). NTC Observations (Memorandum, AFZJ-CG, 20 Nov 85). Fort Irwin, CA: U.S. Army National Training Center.

Scott, T. D. (1980). Tactical training for ground combat forces. Armed Forces and Society, 6(2), 251-231.